Regional Information Report No. 1J07-15

Project Operational Plan for the 2007 Southeast Alaska Herring Stock Assessment

by

Marc Pritchett

October 2007

Alaska Department of Fish and Game Division of Commercial Fisheries

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, Special Publications and the Division of Commercial Fisheries Regional Reports. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	\$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

Herring in Southeast Alaska are harvested for commercial bait, commercial sac roe, commercial spawn-on-kelp, subsistence spawn-on-kelp, and personal use fisheries and department test fisheries. The Southeast Alaska Herring Management plan (5 AAC 27.190.(3)) requires that the department shall assess the abundance of mature herring for each stock before allowing fishing to occur. This Project Operation Plan outlines the 2007 monitoring program for herring spawning stocks in Southeast Alaska and data collection needed for herring spawn biomass estimates and forecast modeling.

Key words: Southeast Alaska, herring spawn, spawning biomass.

INTRODUCTION

In 1971 the Alaska Department of Fish and Game (ADF&G) instituted a herring research program to evaluate herring stocks in Southeast Alaska. Visual estimates, hydroacoustic surveys, and spawn deposition surveys using scuba diving have been used for biomass assessment, particularly in areas judged to support significant herring populations. This Project Operational Plan (POP) describes the data required for assessing the abundance and condition of herring populations in Southeast Alaska and the methods and rationale for collecting those data. Data generated during these stock assessment programs are used directly in the management of all commercial herring fisheries conducted in Southeast Alaska.

The data described in this POP are used as input into two different stock assessment models used to determine historic abundance and forecast future abundance of herring populations. These models include an age-structured analysis (ASA) model and a biomass accounting model.

Historically, biomass estimates and abundance forecasts of mature herring in Southeast Alaska were either developed from hydroacoustic surveys or, more recently, the product of estimates of egg density and area of spawn deposition (called “spawn deposition” method). Presently the ASA model is used for herring populations with longer (i.e. > 10 years) time-series of stock assessment data and the biomass accounting model is used for all other populations. The two methods are not mutually exclusive. Spawn deposition data, upon which the spawn deposition method is completely reliant, is also an important element of ASA and biomass accounting models. A primary difference between the three methods is the amount of data needed to conduct the respective analyses. Spawn deposition analysis uses only the most recent spawn deposition data and no specific age composition or weight data to yield an estimate of current and future biomass. A standard number of eggs per ton (based on data specific for that area (if an estimate is available) or the closest area where an estimate is available) of herring was applied to the total egg estimate to compute spawning escapement. In contrast, the ASA uses a time series of age compositions and weights-at-age in conjunction with spawn deposition to estimate biomass. Biomass accounting is based on spawn deposition estimates adjusted for natural mortality, age-specific growth, and recruitment. Beginning in 1993, ASA, with auxiliary information, has been used to estimate the abundance of herring for five major southeastern herring fishery populations: for the 1994 season in Sitka, Seymour Canal, Revillagigedo Channel (Kah Shakes/Cat Island), and Craig/Klawock, with Tenakee Inlet added for the 2000 season. These five fishing areas or populations have a sufficiently long time series of data to permit the use of ASA for estimating historical and forecasting future biomass. Other areas, which may support significant herring fisheries but lack data time-series suitable for ASA, are candidates for biomass accounting. This approach began in 1996 and biomass accounting forecasts have been made for West Behm Canal, Ernest Sound, Ship Island, Hobart Bay/Port Houghton, and Hoonah Sound.

The principal outputs from all models are forecasts of mature herring biomass for the ensuing year. These forecasts are compared to stock-specific threshold biomass levels to determine whether a fishery will be allowed in a particular area. This biomass forecast is coupled with appropriate exploitation rates to determine the commercial fishing quota.

OBJECTIVES

The ASA model uses a least-squares procedure to yield estimates of historical abundance that are as consistent as possible with the objective estimates listed below. In the context of a least squares procedure, the objective estimates may be thought of as the "observed" data, and the ASA model estimates, derived to be as close to the "observed" data as possible, as the "expected" values.

All three forecasting models are currently deterministic models. That is, the error structure of parameter estimates used as input into the models are not expressly accounted for in the models, nor do the models provide variances for resulting parameter estimates, such as abundance of age-3 herring. If the models were stochastic, the desired precision of input parameter estimates (e.g. catch age compositions) might be dictated partly by the desired precision of output parameter estimates. Until the ASA model is sufficiently refined to account for variability in both input and output parameters, sampling design criteria related to sample sizes and variance estimation will be determined individually for each of the objective estimates listed below, and largely independent of the influence of the estimates on the ASA model. Sampling designs for each objective estimate will account for the usual tradeoffs between the costs of acquiring the data and the precision of resultant estimates.

A more detailed explanation of the ASA model and how the objective estimates are used in the model are provided by Carlile et al. (1996).

Objective 1—Estimate total annual herring spawn deposition.

Estimates of spawn deposition (total numbers of herring eggs), in conjunction with information on fecundity, yield estimates of escapement or absolute abundance for use in both the biomass accounting and ASA models. We will use target-sampling intensities sufficient to achieve estimates of mean egg density so the lower bound of the one-sided 90% confidence interval is within 30% of the mean density. Egg density is sampled on transects by scuba divers. Estimated lengths of beach with herring spawn, the second critical component for abundance estimates, will be determined with aerial and skiff surveys.

Objective 2—Estimate fecundity of herring in S.E. Alaska

As indicated under Objective 1, estimates of fecundity are used with spawn deposition estimates to determine absolute abundance of herring populations. In 1995, 1996, 1998 and 2005 fecundity-at-weight estimates were obtained for one or more of the four major herring spawning areas (Sitka, Craig, Revillagigedo Channel, and Seymour Canal). This procedure requires sufficient samples of female herring distributed optimally among ten 20-g weight classes to promote estimates of fecundity-at-weight at the extremes of the weight range that are within +/-30% of the predicted fecundity, 90% of the time. No additional fecundity at weight estimates are expected to be obtained in 2007 due to resource limitations.

Objective 3—Estimate age composition of herring in commercial catches.

To estimate the historical abundance and forecast future abundance of herring, the ASA model uses catch and weight-at-age data to produce estimates of abundance, commercial gear selectivity, and natural mortality. These estimates yield model-estimated catch age compositions as close to field-estimated (i.e. observed) catch age compositions, mature age compositions, and spawn depositions as possible. Based on multinomial sampling theory, sufficient samples will be obtained to promote estimates of catch age composition that are within ±5% of the true age composition, on an absolute basis, 90% of the time.

Objective 4—Estimate age composition of mature herring populations.

As with catch age compositions, age compositions of mature herring populations based on cast net sampling of pre-spawning and spawning herring or trawl sampling of pre-spawning herring, serve as "observed" data for the ASA model. The model estimates age-3 abundance, maturity-at-age, natural mortality, and estimates of catch-at-age to yield model estimates of mature age composition as close to the "observed" estimates of age composition as possible. Target precision for estimates of mature age composition is the same as for catch age compositions.

Objective 5—Estimate age-specific weights and lengths of mature herring.

Age specific weights are necessary to estimate the "observed" numbers of herring caught at age. Numbers of fish sampled to estimate mean weights-at-age are dictated by the precision guidelines advanced for determination of age compositions (Objective 4), since the same fish sampled for age composition estimates are used to estimate mean weights-at-age. Therefore the precision of weight estimates attainable will fluctuate.

METHODS

DIVE OPERATIONS

An ADF&G research vessel (e.g. *R/V Kestrel*) will be on site during spawn deposition surveys of each area and serve as the support vessel and base for all dive operations. The only exception anticipated is the possible use of skiffs for day trips near Ketchikan for the West Behm Canal stock and north of Juneau in the Lynn Canal area (i.e. Berners Bay). The *R/V Kestrel* will accommodate all members of the dive team (usually six divers), in addition to vessel officers (usually three Boat Officers) for extended periods. Typically, the support vessel remains in a location central to dive activity during the survey.

Actual diving will be conducted from outboard powered skiffs. Three-person dive teams will be assigned to a skiff. All dives will be conducted in pairs, with one team member remaining in the skiff to monitor surface traffic and provide support and assistance to the diving members of the team. Team members will rotate diving/tending responsibilities. Equipment required for dive surveys, such as scuba gear and sampling/data collection equipment, is assembled on-board the support vessel to reduce unnecessary trips between support vessel and dive site. While conducting surveys, teams may be separated from the support vessel by as much as 5 nautical miles though actual distances will be kept at a minimum. All dive operations will conform to procedures described in the department's current Dive Safety Manual.

Spawn Deposition

Aerial Surveys

Beginning in mid-March, the historical start of herring spawning in some areas, fixed-wing aerial surveys will be conducted in locations where spawning is anticipated. Flights will be coordinated within each management area by the Area Management Biologist.

During aerial surveys ADF&G personnel indicate on a chart the shoreline where active spawning occurs. Additionally, indications of herring schools, presence of recent or old milt, presence and numbers of seabirds and marine mammals, and other information relevant to herring spawning, is noted. On occasion, the aircraft will land to collect herring samples for estimates of age, weight, and length, using a cast net. Aerial surveys will continue until active spawning is no longer observed in an area.

Upon completion of an aerial survey, notes will be transcribed and presented, with charts indicating spawn activity, to the herring research biologist. Spawn data from charts will be transferred to GIS to calculate final spawn mileage estimates and help to determine position of transects used for spawn deposition dive surveys.

Sampling Design

A two-stage sampling design, similar to that of Schweigert et al. (1985), is used to estimate the density of herring eggs at selected spawning locations in Southeast Alaska. The field sampling procedure entails two-person scuba teams swimming along transects (first stage of sampling) and recording visual estimates of the number of eggs within a square, 0.10 m^2 sampling frame (second stage of sampling) placed on the bottom at fixed distances along the transects.

The specific approach is as follows: diver 1 holds a 0.10 m^2 sampling quadrate (frame) with an attached compass. Diver 2 holds an underwater writing slate with an attached diving computer for depth and dive time at depth, along with an attached data sheet for recording distance covered, depth, bottom type, percent vegetative cover, most prevalent vegetation type, number of herring eggs observed, and other comments. Diver 1 sets a compass course perpendicular from the beach. Starting at a point approximately 2.5 m inside any intertidal spawn, or at the water line if no intertidal spawn is observed, divers swim along the pre-determined course, and place the sampling frame systematically (to avoid biased placement of the frame) every five meters. Distance is measured using a 5-meter line tied to the sampling frame. Divers stop every five meters. If eggs are not present the estimate is entered as “0”. When eggs are present, diver 1 visually estimates the number of eggs observed within the entire water column defined by the frame. Often the frame cannot be placed on the bottom without displacing eggs and vegetation and must be held in mid-water column. This may require estimating numbers of eggs both above and below the frame as they occur on substrate. Diver 1, using hand signals, indicates his estimate to diver 2 to record. Diver 2 also records depth, distance covered, bottom type, percent vegetative cover, vegetative type, and any additional observations. Vegetative type will be coded using a key that groups various algae and marine and intertidal plants species into categories (Appendix A). Similarly, bottom type will be coded according to Appendix B. Since frames are spaced equidistant along transects, the number of frames is also used to compute individual transect length.

Starting points for transects are located randomly along the shore within areas where aerial or skiff surveys indicated probable spawn deposition. Transects are oriented perpendicular to the shoreline. Dives are limited generally to 15 meters MLLW because deeper dives severely limit total bottom times for scuba divers and pose safety risks when done repetitively over several days. In addition, little if any herring egg deposition normally occurs deeper than 15 m.

Upon completion of a survey dive, all data will be entered into a database on-board the supporting research vessel. When possible, the collector of the data will complete data entry.

Diver Calibration

Since visual estimates, rather than complete counts of eggs within the sampling frames are recorded, measurement error occurs. To minimize the influence of this measurement error on final estimates of total egg deposition, diver-substrate-specific correction coefficients (c_h) are used to adjust estimates of egg density. Correction coefficients are estimated by double sampling (Jessen 1978) a sample of frames separate from those estimates obtained along regular spawn deposition transects. This involves visually estimating the number of eggs within a sampling frame and then collecting all of the eggs within the frame for later enumeration in the laboratory. To collect the eggs, divers will carefully collect all of the kelp containing eggs located within the frame and place the samples in collection bags. Eggs that are attached to rocks and other uncollectable substrates often remain within the frame and are not part of the estimate. All samples will be preserved in a 100% salt brine solution until laboratory analysis. A detailed description of the processing and counting of collected eggs in the laboratory is provided in Blankenbeckler (1987). In addition to diver estimates, when conditions permit (e.g. proper substrate, visibility), samples will be photographed prior to estimates and collection. A photographic record may allow for later comparison of diver to lab estimates. Photographs may also provide a venue for future training both in herring egg estimation and kelp identification.

Given the visual estimates and actual counts of eggs, the diver-specific correction factors are estimated as:

$$c_{ih} = \frac{\bar{r}_{hk}}{\bar{v}_{hk}} \tag{1}$$

where c_{ih} is the estimated correction factor for diver h, v_{hk} is the mean visual estimate of egg numbers for diver h, *and* $\bar{r}_{hk}$ is the mean laboratory count of egg numbers for diver h.

Estimates of Total Egg Deposition

For each spawning area, i, total egg deposition is estimated as:

$$t_i = a_i \bar{d}_i, \tag{2}$$

where t_i is the estimated total deposition of eggs for spawning area i, a_i is the estimated total area (m^2) on which eggs have been deposited at spawning area i, and $\bar{d}_i$ is the estimated mean density of eggs (eggs/m^2) at spawning area i.

The total area on which eggs have been deposited is estimated as:

$$a_i = l_i w_i \,, \tag{3}$$

where l_i is the total meters of shoreline receiving spawn (determined from aerial and skiff surveys) at a spawning area i, and w_i is the mean length of transects conducted at a spawning area i.

The mean density of eggs/m^2 at area i ($\overline{d_i}$) is estimated as:

$$\overline{d}_i = 10 * \left[\frac{\sum_h \sum_j \sum_k v_{hijk} c_{hk}}{\sum_h m_{hi}} \right] \tag{4}$$

where v_{hij} is the visual estimate of egg numbers by diver h, at area i, quadrate j, on kelp type k. The c_{hk} term refers to a diver-specific, kelp-specific correction factor to adjust visual estimates made by diver h on kelp type k, and m_{hi} is the number of quadrats visually estimated by diver h at area i. Divers visually estimate egg density within 0.1 m quadrats. Multiplying by 10 expands the mean density from a 0.1 m^2 to a 1.0 m^2.

Sample Size

The statistical objective of spawn deposition sampling is to estimate herring egg densities (per quadrate) so the lower bound of the one-sided 90% confidence interval is within 30% of the mean density. This will also achieve the objective of estimating the total spawn deposition at a particular location with the specified precision. A one-sided confidence interval is used because we are concerned more with avoiding overestimating, rather than avoiding underestimating the densities of spawn deposition. Since spawn deposition surveys are conducted as two-stage sampling, target precision can be achieved by changing the number of transects per nautical mile of shore and/or by changing the number of quadrates within transects per nautical mile of shore. Sampling optimization, which accounts for both the costs and variances specific to each stage of sampling, could be used to obtain optimum estimates of egg density given constraints on precision and cost. This approach would necessitate some flexibility in varying both the transect density (i.e. number of transects per nautical mile of shore) and quadrate density (i.e. number of quadrates per meters of transect) at the various spawning areas. Since a length of line is now used to measure inter-quadrate distances, it would be practical to optimize the spawn deposition sampling by varying not only the number of transects per nautical mile, but also the number of quadrates per transect specific to each spawning area. During the 2007 season, methods of optimizing spawning surveys inseason may be explored as resources allow. However, to simplify the sampling and reduce chances of error, a standard quadrate spacing of one quadrate every 5 m of transect will be maintained. This standardization simplifies estimation of desired sample sizes, since the target precision is achieved by changing only the number of transects.

The desirable number of transects to achieve a specified precision is estimated as:

$$n = \frac{\left(S_b^2 - \frac{S_2^2}{\overline{M}} + \frac{S_2^2}{\overline{m}} \right)}{\left(\frac{x\overline{d}}{t_\alpha} \right)^2 + \frac{S_b^2}{N}}, \tag{5}$$

where:

n	=	number of transects needed to achieve the specified precision,
S_b^2	=	estimated variance in egg density among transects,
S_2^2	=	estimated variance in egg density among quadrates within transects,
$\overline{M}$	=	estimated mean width of spawn,
$\overline{m}$	=	estimated mean number of 0.1 m quadrates per transect,
x	=	specified precision, expressed as a proportion (i.e. 0.3 = 30%),
$\overline{d}$	=	overall estimated mean egg density,
t_a	=	critical t value for a one-sided, 90% confidence interval,
N	=	estimated total number of transects possible within the spawning area.

These preliminary estimates may be obtained from the prior year's spawn deposition surveys, or may be obtained from preliminary sampling from the current years' sampling and updated as the current years' survey proceeds (Table 1). The latter approach is preferred if possible. Current available resources preclude obtaining sample size estimates from recent data; sample sizes calculated from 2000 data will be used in 2007. From a practical standpoint, the number of transects conducted in an area will be set as a minimum of 15 and not to exceed 40.

Transect Location

Once the desired number of transects per nautical mile of spawn is determined, transect location is decided through a process of measuring the distance of shoreline that received spawn and then randomly selecting locations. The final mileage is obtained using GIS software.

Shoreline measurement and transect placement can be subjective and depend on the location of spawn deposition relative to the shoreline, bottom contour and depth, and map resolution. Fine measurement of a convoluted shoreline may substantially increase distance but may not be appropriate for instances when spawn deposition does not closely follow the shoreline. In such situations, less resolution is used for measurements and transects are placed perpendicular to a "theoretical" shoreline so they intersect the spawn in a meaningful way. Conversely, spawn may closely follow a convoluted shoreline, requiring finer resolution of measurements, and transects are placed perpendicular to the actual shoreline, contingent upon physical features, such as depth, bottom slope, and distance to the opposite shore. For example, a steep sloped shore with a narrow band of spawn habitat (e.g. Sitka) requires much finer shoreline mapping as opposed to an area with broad shallow waters (e.g. Cat Island) interspersed with rocks and reefs at some distance from shore.

The product of the total measured shoreline and the estimated optimal number of transects per nautical mile (Table 1) determines the total number of transects to be surveyed in an area. Total measured shoreline that received spawn is divided into tenths of a nautical mile and each of these segments becomes a candidate for transect location. The number and location of transects to be surveyed are then selected from these segments using a random number generator.

FECUNDITY

Due to resource limitations, it is unlikely there will be an opportunity for herring fecundity sampling in 2007. But if the opportunity develops, the following general protocol will be followed:

Sampling Design

Estimates of fecundity are used with spawn deposition estimates to determine absolute abundance of herring populations. Sufficient samples of female herring, distributed optimally among nine, 20-g weight classes will be collected to promote estimates of fecundity-at-weight at the extremes of the weight range that are within +/- 30% of the predicted fecundity, 90% of the time. In 1995, 1996, 1998, and 2005 fecundity-at-weight estimates were obtained for the four major herring spawning areas: Sitka (1995, 1996, 1998, 2005), Craig, Kah Shakes/Cat Island (1996), and Seymour Canal (1996).

Sampling will be conducted so that regression estimates of fecundity as a function of weight can be obtained. Analyses of historical fecundity-at-weight data from Southeast Alaska herring suggests a slight non-linearity in the relationship. Therefore, sampling will be conducted from the full spectrum of weight classes of mature herring.

Herring samples must be obtained as close to spawning as possible though sampling should not occur during spawning (to prevent sampling of partially spent females). Sample timing is crucial to provide real time estimates of potential egg deposition. Sampling procedures may occur in conjunction with herring sampling that occurs prior to the sac roe fishery using either seine sets or cast net samples; samples from multiple locations are preferred.

Sample Size

In Southeast Alaska, weights of mature herring may range from approximately 40g for an age-3 fish to over 200g for an age-10 fish. Given this likely range of weights, and the need to sample for a possible nonlinear relationship, sampling will be conducted equally within this range of weights. Sampling will be conducted by selecting from seine or cast net samples a minimum of 10 reproductively mature female herring from each of the following 20g weight categories: <80, 80-99, 100-119, 120-139, 140-159, 160-179, 180-199, 200-219, ≥220 grams. This will yield a minimum of 90 herring to be analyzed to define the fecundity relationship. This total sample size is dictated largely by limitations on the number of fish that can reasonably be processed given available personnel. This sample size is also consistent with previous fecundity sampling sizes. All herring collected for potential fecundity sampling will be individually bagged to prevent cross contamination and to make it readily apparent if a herring is loosing eggs.

Ovary Removal

From the collected herring, appropriate size females will be selected and weighted to the nearest gram. The standard length (tip of snout to posterior margin of the hypural plate) of each fish will be measured to the nearest millimeter. Using a sharp dissecting knife or scissors a shallow incision will be made from the vent to the gill cage, exposing the skeins.

Fecundity Estimate

The skein will be carefully removed and eggs separated from the membrane (removing as much membrane and "non-skein" tissue as possible without loosing or breaking any eggs). The skein's weight will be recorded to the nearest 0.01 gram. The skein/eggs will then be placed into a suitable container or weight paper. Three skein sub samples will be weighted to the nearest 0.01 gram. The number of eggs in each sub sample will be counted. Ideally, each sub sample should contain approximately 300 - 500 eggs. All weights and counts will be recorded and identified with that fish's total weight and length. There is still some concern about counting eggs and herring egg "stickiness". If eggs are too sticky to accurately count, they may be boiled or washed in either a brine or KOH solution prior to counting. Other reagents and methods may be investigated as needed. As sub sample weight has already been obtained, the wash procedure will not alter the sub sample weight though care must be taken to avoid loss or destruction of eggs in the sub sample. This procedure is designed to avoid using caustic preservatives and reagents such as Gilson's solution.

Data Collected

When completed, the data collected shall include:

Spawning Stock (e.g. Sitka Sound)

Collection Date, Sample Date

Location (e.g. Old Sitka Rocks)

Gear (e.g. purse seine)

length (mm)

weight (grams)

sub samples weights (x3)

sub samples counts (x3)

sampler (technicians completing project).

A separate data sheet can be used for each weight category to more easily keep track of the number of herring sampled in each category.

Data will be entered into a spreadsheet but preferable, if available, into the department's herring database. Once entered, average number of eggs per gram will be calculated and extrapolated to estimate the number of eggs for that herring.

CATCH AGE COMPOSITION

Sampling Design

Samples will be collected from at least three and preferably four different vessels participating in each of the commercial herring fisheries. Apportioning samples among vessels and positions within sets is intended to promote more representative estimates of age compositions. Sampling from tenders at the processing plants may be required for the winter bait fishery, but is not preferable due to scale loss. Samples will be stored plastic bags (large garbage bag) in 5-gallon buckets and shipped to the Juneau tag lab for processing at the earliest convenience. Information with each sample will include: date of set, location of set, name of vessel making the set, name of person collecting sample, commercial gear used in making the set and if available, the approximate size of the set. Samples will be collected from all commercial fisheries conducted during the year. Labels will be included both inside and outside each bucket.

Sample Size

Based on multinomial sampling theory (Thompson, 1987), a sample size of 511 fish is sufficient to assure age composition estimates that deviate no more than 5% (absolute basis) from the true value, 90% of the time. To achieve a sample size of approximately 500 fish and promote adequate sampling from a cross section of the commercial catch, approximately 100 herring will be taken from each of at least five different vessels participating in the commercial fishery.

MATURE AGE COMPOSITION

Sampling Design

Cast net and/or seine samples will be collected annually from areas that have historically been sampled and/or which have significant pre-spawning and spawning activity.

Sample Size

A minimum of 125 fish will be taken from each of at least four different times and/or sites within the general spawning locale prior to or during the onset of the major spawning event (total sample size is 500 fish). Sampling gillnet sac roe fishery areas should be completed prior to the onset of any commercial fishery in the area.

AGE-SPECIFIC WEIGHT AND LENGTH

Sampling Design

The sampling design for estimating age-specific weight and length is dictated by the design used to estimate mature and catch age compositions, since the same fish are used for estimating age, weight, and length.

Sample Size

The precision of the estimates of mean weights and lengths-at-age will vary depending upon age composition of populations and therefore the numbers of herring within the various age classes among the total of 500 fish sampled. In addition, precision will vary depending upon inherent variability in weights among fish within the various age classes.

SPECIAL PROJECTS

Egg Development

During spawn deposition surveys, efforts will be made to collect herring eggs from known spawning sites and dates. Water temperature will be monitored (recording sensors are in place at numerous herring spawning locations) and correlated with the stages of herring egg develop. This is a new, non-funded, pilot project that will be completed as time, resources, and opportunity occur.

Photographic Training Aids

When conditions permit, underwater photos of herring spawn will be taken prior to collecting calibration samples and while conducting standard transects. These photos can be used as a training aid for both algae identification as well as herring spawn estimates. Calibration samples and photos will later be combined with lab estimates for comparison.

SCHEDULES

Herring stock assessment data collection schedule, 2007: Dates of spawn deposition surveys are approximately April 1 – May 22. Actual survey dates are dependent on herring spawn timing.

Surveys are anticipated to be conducted in the following locations in this sequence (Appendix C):

Sitka Sound

Craig

Kah Shakes / Cat Island (dependent on spawn mileage, this area has not been surveyed since 2001)

West Behm Canal

Bradfield Canal (tentative)

Ernest Sound

Tenakee Inlet

Hoonah Sound

Hobart Bay / Port Houghton

Seymour Canal

Berners Bay (Lynn Canal).

PARTICIPATING DIVERS

The following department divers are scheduled for either one or both herring spawn deposition dive surveys: Marc Pritchett, Jeff Meucci, Kyle Hebert, William Bergmann, Zac Hoyt, Dave Gordon, Troy Thynes, Justin Breese, Sherri Dressel, and Bo Meredith.

DATA ENTRY / DATABASE AND SOFTWARE REQUIREMENTS

All spawn deposition data will be entered into the "portable ALEX" database by a designated dive team member within the same day of data collection (if possible) to maximize recall of dives. Ideally, the collectors of the data will enter data. Upon completion of the cruise, data files will be imported into the ALEX master database.

OTHER NECESSARY RESOURCES

The *R/V Kestrel*, based in Petersburg, will be used as the support research vessel and base dive platform for herring spawn deposition cruises. This is a 105-foot vessel, capable of accommodating six divers in addition to three vessel officers. It is equipped with compressors for on-board filling of scuba tanks with air and NITROX. A 36% Nitrox breathing mixture will be used for all dives to enhance safety. All diving will adhere to those guidelines and procedures outlined in the department's Dive Safety Manual (Hebert 2006) and emergency response to dive accidents will follow the 2007 dive safety plan.

Two aluminum skiffs that have been enhanced for diving purposes will accompany the support research vessel.

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Schweigert, J. F., C. W. Haegele, and M. Stocker. 1985. Optimizing sampling design for herring spawn surveys in the Strait of Georgia, B.C. Can. J. Fish. Aquat. Sci. 42:1806-1814.

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Table 1.–Estimated number of samples required to achieve statistical objective.

	Estimated target transects/nmi		
	Based on 1994 analysis	Based on 1997 analysis	Based on 2000 analysis
Sitka	0.2	0.6	0.3
Revilla Channel	1.0	1.8	3.4
Seymour Canal	2.8	2.4	1.2
Craig	0.8	3.1	1.3
Hobart/Houghton	4.5	1.7	3.6
Vixen Inlet (Ernest Sound)	1.9	5.0	3.5
Hoonah Sound	2.9	1.0	0.7
Tenakee Inlet	5.1	1.2	1.6
West Behm Canal	-	0.4	1.7

APPENDICES

Appendix A.–Key to vegetative substrate types used for herring spawn deposition survey.

CODE	EXPANDED CODE	SPECIES INCLUDED	LATIN NAMES
AGM	Agarum	Sieve kelp	*Agarum clathratum*
ALA	Alaria	Ribbon kelps	*Alaria marginata, A. nana, A. fistulosa*
ELG	Eel grass	Eel grass, surfgrasses	*Zostera marina, Phyllospadix serrulatus, P. scouleri*
FIL	Filamentous red algae	Sea brush, poly, black tassel	*Polysiphonia pacifica, P. hendryi, Pterosiphonia bipinnata*
FIR	Fir kelp	Black pine, Oregon pine (red algae)	*Neorhodomela larix, N.oregona*
FUC	Fucus	Rockweed or popweed	*Fucus gardneri*
HIR	Hair kelp	Witch's hair, stringy acid kelp	*Desmarestia aculeata, D. viridis*
LAM	Laminaria	split kelp, sugar kelp, suction-cup kelp	*Laminaria bongardiana, L. saccharina, L. yezoensis (when isolated and identifiable)*
LBK	Large Brown Kelps	Five-ribbed kelp, three-ribbed kelp, split kelp, sugar kelp, sea spatula, sieve kelp, ribbon kelp	*Costaria costata, Cymathere triplicata, Laminaria spp., Pleurophycus gardneri, Agarum, Alaria spp.*
MAC	Macrocystis	macrocystis	*Macrocystis integrifolia*
NER	Nereocystis	Bull kelp	*Nereocystis leutkeana*
RED	Red algae	All red leafy algae (red ribbons, red blades, red sea cabbage, Turkish washcloth)	*Palmaria mollis, P. hecatensis, P. callophylloides, Dilsea californica, Neodilsea borealis, Mastocarpus papillatus, Turnerella mertensiana*
ULV	Ulva	Sea lettuce	*Ulva fenestrata, Ulvaria obscura*
COR	Coralline algae	Coral seaweeds (red algae)	*Bossiella, Corallina, Serraticardia*

Appendix B.–Key to bottom types used for herring spawn deposition survey.

CODE	EXPANDED CODE	DEFINITION
RCK	Bedrock	Various rocky substrates > 1 meter in diameter
BLD	Boulder	Substrate between 25 cm and 1 meter
CBL	Cobble	Substrate between 6 cm and 25 cm
GVL	Gravel	Substrate between 0.4 cm and 6 cm
SND	Sand	Clearly separate grains of < 0.4 cm
MUD	Mud	Soft, paste-like material
SIL	Silt	Fine organic dusting (very rarely used)
BAR	Barnacle	Area primarily covered with barnacles
SHL	Shell	Area primarily covered with whole or crushed shells
MUS	Mussels	Area primarily covered with mussels
WDY	Woody debris	Any submerged bark, logs, branches or root systems

Appendix C.–Southeast Alaska traditional herring spawning locations.